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SURVEYS FOR WINTERING BIRDS OF PREY IN SOUTHEASTERN COLORADO: 1983–1988

DAVID E. ANDERSEN AND ORRIN J. RONGSTAD

ABSTRACT.—From 1983 through 1988 we conducted 45 road surveys for wintering birds of prey on the Piñon Canyon Maneuver Site in southeastern Colorado. Surveys were conducted from January through mid-March along a 75.7 km survey route that passed through pinyon (*Pinus edulis*)-juniper (*Juniperus monosperma*) and shortgrass prairie habitat. Twelve raptor species were sighted on these surveys, with Red-tailed Hawk (*Buteo jamaicensis*), American Kestrel (*Falco sparverius*), Golden Eagle (*Aquila chrysaetos*), and Loggerhead Shrike (*Lanius ludovicianus*) together representing over 73% of all sightings. As a group, birds of prey were consistently sighted most frequently (raptors/km) along the limestone breaks/pinyon-juniper section of the survey route ($P < 0.05$). Indices to overall raptor abundance varied little among winters, although relative abundance varied significantly during the 6-year period ($P < 0.05$).

Road surveys have historically been used to index densities of wintering birds of prey (Nice 1934; Leopold 1942; Craig 1978; Fuller and Mosher 1981). These surveys have also been used to estimate density (Andersen et al. 1985), distribution (Gessaman 1982), and total population size (Craighead and Craighead 1956; Woffinden and Murphy 1977; Bildstein 1978), determine perch (Marion and Ryder 1975; Preston 1980) and habitat use (Koplin 1973; Fischer et al. 1984), and make comparisons in relative abundance among years and areas (Johnson and Enderson 1972; Bauer 1982). However, most surveys in open habitats have been conducted where utility poles parallel roads, which potentially bias raptor distribution (Stahlecker 1978). Additionally, many surveys have been conducted for only 1 or 2 consecutive winters in a given location.

Here, we report on the results of road surveys for wintering birds of prey that were conducted for 6 consecutive winters in an area where utility poles were not present along roads. Our objectives were to index wintering populations of birds of prey and to determine which habitats in southeastern Colorado consistently were used by wintering raptors.

STUDY AREA AND METHODS

Road surveys were conducted on the 1040 km^2 Piñon Canyon Maneuver Site (PCMS), in Las Animas County in southeastern Colorado. Elevation on PCMS ranged from 1300–1700 m, and topography consisted of broad, moderately sloping uplands bordered by the Purgatoire River Canyon on the east, limestone hills on the west, and a basalt hogback on the south (U.S. Dept. Army 1980). Annual precipitation averaged approximately 32 cm, fluctuating widely from year to year and between areas of the parcel (U.S. Dept. Army 1980). Climate was classified as mid-latitude semiarid and mean monthly temperature ranged from −1°C in January to 23°C in July.

Vegetation on PCMS was dominated by shortgrass prairie and pinyon (*Pinus edulis*)-juniper (*Juniperus monosperma*) woodland (Costello 1954; Kendeigh 1961). Three major and distinct habitats occurred on PCMS (Fig. 1). sandstone breaks/pinyon-juniper (sandstone) habitat occurred along the Purgatoire River Canyon and associated side canyons, shortgrass prairie (prairie) habitat covered the central, northern, and extreme western portion of PCMS, and limestone breaks/pinyon-juniper habitat (limestone) occurred in the west and northwest portions. Blue grama (*Bouteloua gracilis*), alkali sacaton (*Sporobolus airoides*), galleta (*Hilaria jamesii*), western wheatgrass (*Agropyron smithii*), walking stick cholla (*Opuntia imbricata*), and small soapweed (*Yucca glauca*) dominated shortgrass prairie vegetation. See Shaw and Diersing (in press) for a detailed description of habitat on PCMS.

We conducted road surveys for wintering birds of prey from 1983 through 1988. Surveys were conducted every 10–14 d from January through mid-March in all winters, except in 1983 when surveys were conducted at 6-d intervals. We selected a 75.7 km route that included 24.6 km (32.5%) of sandstone habitat, 36.0 km (47.6%) of prairie, and 15.1 km (19.9%) of limestone (Fig. 1). The route was selected on the basis of distribution of existing roads that were likely to be passable in winter, and so that each major habitat was represented. Utility poles were largely absent from the PCMS and did not parallel the survey route.

Survey methods followed those outlined by Andersen et al. (1985). For each raptor sighted, we recorded species, age, sex, individual description (color morph), time of sighting, perch characteristics, direction of flight, and behavior, where applicable. Starting points were alternated between ends of the route and we began surveys approximately 0.5 hr after sunrise. Surveys were initiated only on days when estimated wind speed was <10 km/hr and cloud cover was <50%. Two observers participated in all surveys and speed was maintained between 25 and 40 km/hr. Surveys were completed in 3–4 hrs.

Statistical procedures follow those outlined in Ryan et al. (1976), Snedecor and Cochran (1980), and Sokal and Rohlf (1980). Multiple comparisons were made using the protected least significant difference (LSD) method (Snedecor and Cochran 1980:234) with an experiment-wise al-

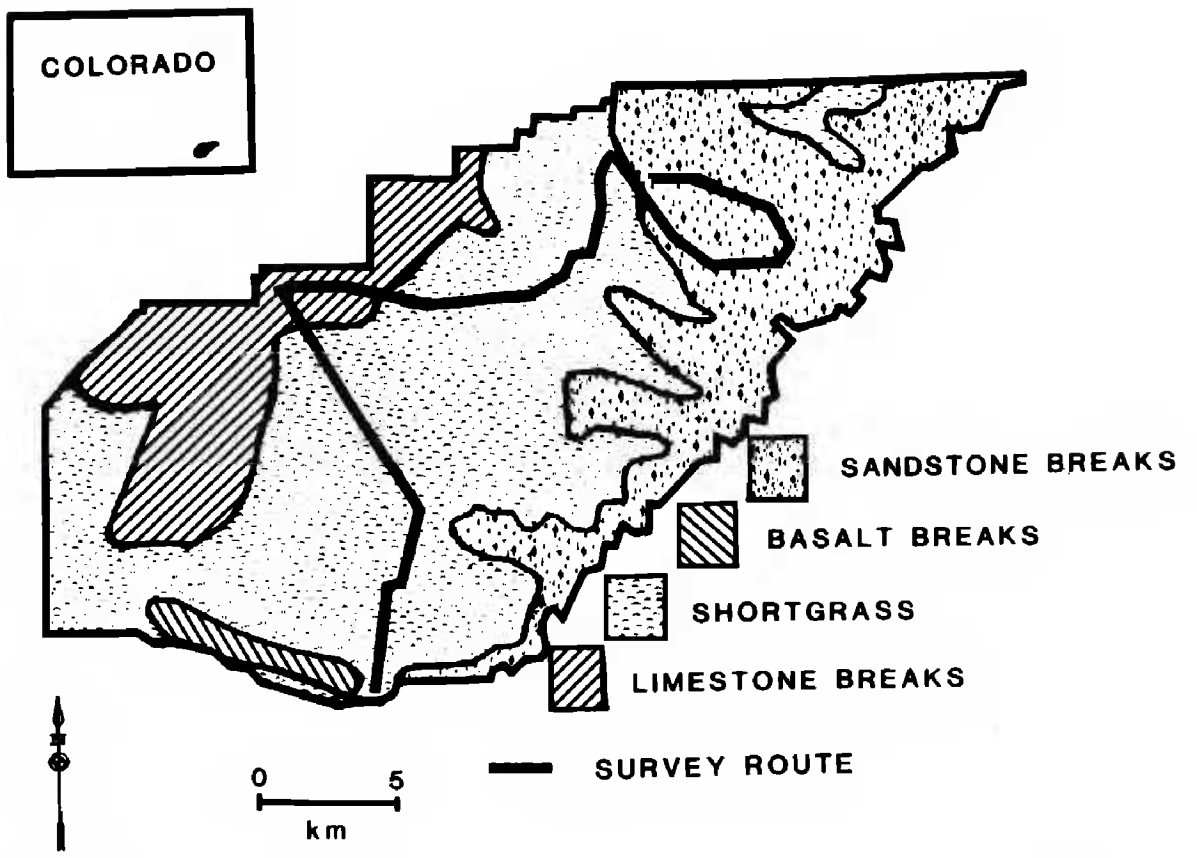

Figure 1. Habitats and survey route for wintering birds of prey on the Piñon Canyon Maneuver Site, Colorado. Sandstone breaks, basalt breaks, and limestone breaks all supported a pinyon-juniper plant association.

pha of 0.05. Surveys were repeated over the same route each winter and we were not able to randomly sample habitats on PCMS. Thus, our analyses do not test for treatment (i.e., habitat) differences (see Hurlbert 1984), only differences among locations in sighting frequency. Years were treated as independent replicates in analysis of variance (ANOVA) procedures.

RESULTS

From 1983 through 1988 we conducted 45 surveys for wintering birds of prey on PCMS. Twelve species of raptorial birds were observed on these surveys (Table 1) with Red-tailed Hawk (48.8%), American Kestrel (13.5%), Golden Eagle (9.4%), and Loggerhead Shrike (9.0%) totalling over 73% of all sightings. Raptors were consistently sighted more frequently in limestone habitats than in either sandstone or prairie habitats (Table 2; 2-way ANOVA, $F = 5.43$; 2,10 df; $P < 0.05$). Variation among winters in raptor densities on PCMS could be related to factors independent of habitat. We adjusted for annual variation in sighting frequency by subtracting yearly mean sighting frequency (habitats combined) from sighting frequency in each habitat (adjusted sighting frequency). Adjusted sighting frequency was significantly higher in limestone habitats than in either sandstone or prairie habitats (1-way ANOVA, $F = 8.16$; 2,15 df; $P < 0.005$; LSD procedures), indicating that winter raptor density was also highest along the limestone section of the survey route.

In the winters of 1982–83 ($\chi^2 = 6.22$, 2 df, $P < 0.05$) and 1984–85 ($\chi^2 = 8.14$, 2 df, $P < 0.025$; Table 2) birds of prey were sighted more frequently (unadjusted sighting frequency) than expected in limestone habitats and less frequently than expected in sandstone habitats, based on the proportion of the survey route that passed through each habitat. No significant differences in sighting frequency were found among habitats in the winters of 1983–84, 1985–86, 1986–87, or 1987–88 (χ^2-tests, all Ps > 0.10). Raptors (species combined) were sighted most frequently (sightings/km) in limestone habitats in every winter ($N = 6$) that surveys were conducted (Exact Randomization Test, $P < 0.005$; Table 2), indicating that raptors were consistently most abundant along the section of the survey route that passed through limestone habitat.

Overall, wintering raptor abundance (species combined) on PCMS was similar among years ($\bar{x} = 14.1$ km/raptor, coefficient of variation = 19.4%). However, counts of individual raptor species sighted on survey routes changed among winters ($\chi^2 = 27.13$, 15 df, $P < 0.05$), indicating that the abundance of different species on PCMS also differed among winters.

Table 1. Birds of prey sighted on a 75.7 km winter[a] survey route on Piñon Canyon Maneuver Site, Colorado from 1983 through 1988. Number of surveys is given in parentheses.

SPECIES	WINTER 82–83 (11)	83–84 (6)	84–85 (8)	85–86 (7)	86–87 (8)	87–88 (5)	TOTAL (45)
Red-tailed Hawk (*Buteo jamaicensis*)	29	16	10	21	20	6	102
American Kestrel (*Falco sparverius*)	4	0	5	10	10	4	33
Golden Eagle (*Aquila chrysaetos*)	6	6	3	1	6	1	23
Loggerhead Shrike (*Lanius ludovicianus*)	2	1	5	7	1	6	22
Prairie Falcon (*Falco mexicanus*)	3	4	2	1	4	3	17
Ferruginous Hawk (*Buteo regalis*)	5	0	0	1	3	1	10
Northern Harrier (*Circus cyaneus*)	0	0	1	0	3	1	5
Rough-legged Hawk (*Buteo lagopus*)	0	2	5	2	2	0	11
Merlin (*Falco columbarius*)	0	0	2	1	1	4	8
Cooper's hawk (*Accipiter cooperii*)	0	1	1	1	0	2	5
Sharp-shinned Hawk (*Accipiter striatus*)	0	2	0	1	1	1	5
Bald Eagle (*Haliaeetus leucocephalus*)	0	0	0	0	2	0	2
Unidentified	0	1	0	0	0	0	1
Total	49	33	34	46	53	29	244
km/sighting	17.0	13.8	17.8	11.5	11.4	13.0	14.1

[a] Surveys were conducted in January, February, and early March.

DISCUSSION

Wintering birds of prey were consistently sighted more frequently in limestone than in any other habitat. Sighting probabilities can differ among habitat types or years (Andersen et al. 1985), although because the number of sightings/habitat/year for each species was small, we were unable to estimate detection functions or raptor densities. However, the probability of detecting a raptor in sandstone and prairie habitats was at least as high as in limestone habitats, based on vegetative characteristics that influence detectability (U.S. Dept. Army 1980; Shaw and Diersing, in press; Millsap and LeFranc 1988). Higher sighting frequencies in limestone habitat indicate that densities of wintering raptors were also highest in limestone habitats.

Local prey abundance (Craighead and Craighead 1956; Enderson 1964; Phelan and Robertson 1977; Newton 1979:289) and availability (Sylvèn 1978; Baker and Brooks 1981) influence winter raptor abundance. On PCMS, we did not have an index to winter prey abundance or availability. However, variation among years in raptor abundance was low, indicating either that prey densities were similar among years, or that factors unrelated to fluctuating prey availability influenced raptor abundance (Bildstein 1978).

As an index to abundance, distance travelled per sighting (habitats combined) ranged from 11.4 km (0.087 raptors/km) in 1983–84 to 17.8 km (0.056 raptors/km) in 1984–85. These indices indicate that winter densities of raptors on PCMS were lower than in similar areas in eastern Colorado in other years: 6.3 km/raptor (Enderson 1965), 5.8 km/raptor (Johnson and Enderson 1972), 8.9 km/raptor (Bauer 1982), and 5.4–8.7 km/raptor (Andersen 1984). Excluding shrikes (to make results comparable with cited studies), distance travelled/sighting on PCMS ranged from 7.7 km in 1983–84 to 20.9 in 1984–85. However, other studies were conducted where utility poles paralleled the survey route (except Andersen 1984) which likely influenced winter raptor distribution (Enderson 1964; Stahlecker 1978) by concentrating raptors along the survey route and increasing the probability of being observed. Thus, winter density on PCMS may be similar to other areas of eastern Colorado where surveys have been conducted and winter sighting frequency on PCMS may be a useful index of winter raptor density in eastern Colorado.

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Table 2. Raptors sighted (by habitat) during winter road surveys conducted on Piñon Canyon Maneuver Site, Colorado from 1983 through 1988. The total survey route was 75.7 km, of which 24.6 km (32.5%) was sandstone, 36.0 km (47.6%) was prairie, and 15.1 km (19.9%) was limestone habitats.

		Habitat					
		Sandstone		Prairie		Limestone	
Winter	No. of Surveys	N	km/Sighting	N	km/Sighting	N	km/Sighting
82–83	11	10	24.5	23	17.2	16	10.5
83–84	6	12	12.3	12	18.0	9	10.1
84–85	8	6	32.8	15	19.2	13	9.3
85–86	7	15	11.5	17	14.8	14	7.6
86–87	8	13	15.1	26	11.1	14	8.4
87–88	5	11	11.2	9	20.0	9	8.4
$\bar{x}$			17.9		16.7		9.0

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Department of Wildlife Ecology, University of Wisconsin, Madison, WI 53706 (DEA and OJR) and Colorado Field Office, U.S. Fish and Wildlife Service, 730 Simms Street, No. 290, Golden, CO 80401 (DEA). Current address of first author: U.S. Fish and Wildlife Service, Minnesota Cooperative Fish and Wildlife Research Unit, Department of Fisheries and Wildlife, University of Minnesota, St. Paul, MN 55108.

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